**Summary thesis: Designing a storage capacity plan for Roerink Food Family**

This report is the end result of the research which was performed to complete the author’s master study Industrial Engineering and Management at the University of Twente. The research was conducted at Roerink Food Family. The performed research gives an answer on

*“What should be the storage capacity plan for the Roerink Food family for different scenarios of future growth?”*

Problem statement
The Roerink food family started their business as a small farm store under the name of Zuivelhoeve in 1981 in Enschede, where they sold self-made desserts, and other dairy products. From this small farm store the company has grown to a medium-sized family business with five subsidiaries: Zuivelhoeve Vers, Van der Poel Desserts, Heks’nKaas, Happy Goat and Zuivelhoeve retail chain. In all those years of growth, increasing and optimizing the production had priority. But to keep handling this growth also warehousing & logistics should have priority.
What raises questions to the company are the multiple locations where products for Zuivelhoeve Vers are stored and the corresponding internal inventory movements. Also the complete separation of Van der Poel Desserts’ logistics and warehousing from the other subsidiaries is undesirable.
Therefore for these two subsidiaries we looked at what the possible alternative scenarios for the warehousing and associated logistics are and how well they do compared to the current situation. This has be done for the current stock levels and under different future growth scenarios.
We compared the alternative scenarios with the current situation based on the operational costs per year, these are the total costs for storage and (internal) transport in a year.

Current situation:
First the current situation for Zuivelhoeve Vers is explained and then the current situation for Van der Poel Desserts, regarding the warehousing and logistics.
In Twekkelo dairy products, like custard and yoghurt for the subsidiary Zuivelhoeve Vers are produced.

*Zuivelhoeve Vers*Since the beginning the production of Zuivelhoeve Vers has remained in Twekkelo, which means that the facility is operative for almost 30 years. Still Zuivelhoeve Vers produces its dairy products at this location, but when the company started to grow, the storage capacity at this site became too small. So over the years the company decided to expand and have an external location for storage capacity in Raalte, this is the warehouse for Zuivelhoeve Vers.
 In Raalte the end-products of the Zuivelhoeve, a small amount of packaging as well as bavarois and end-products for the Zuivelhoeve Retail Chain are stored. Which means that there is ambient (dry, 10-20°C), cold(-18°C)and refrigerated(0-6°C) storage at this warehouse.
Besides this location in Raalte for extra storage capacity, the location in Oldenzaal is also for ¾ in use by the Zuivelhoeve for storing packaging and raw materials. The result of this construction is that every day internal inventory movements take place between the locations.
Because of the still ongoing growth and the undesirable internal inventory movements, the company is planning to build extra storage capacity next to this production site in Twekkelo and does not want to use the location in Oldenzaal anymore for storage of Zuivelhoeve vers.

Customers of Zuivelhoeve Vers are mainly located in Germany and the Netherlands. In the Netherlands, Zuivelhoeve Vers supplies its products to the Out-of-Home market, several retail chains and the Zuivelhoeve Vers Retail chain. In Germany and Belgium Zuivelhoeve Vers supplies its products just to retail chains. All these customers (except for REWE FL retail chain in Germany) are supplied from the warehouse in Raalte directly by the logistics service company (Nagel) to the customer. The transport to the REWE FL retail chain starts in Raalte, from Raalte Nagel transports the end products to one of their distribution centers in Germany (Borgholzhausen). From Borgholzhausen the goods are transported at a cheaper rate to the REWE FL retail chain, which has several sites in Germany.

The total operation costs Zuivelhoeve Vers in this current situation are: €1,919,117.70

*Van der Poel Desserts*Added as latest subsidiary to the Roerink Food Family is Van der Poel desserts. Van der Poel is since the end of 2014 part of the Roerink Food Family, but it has existed since 1925 and it is known for its ice and desserts. Over the years Van der Poel Desserts has become an international organization.
Because of the fact that Van der Poel Desserts was an already existing organization, it has its own MRP system, different from the MRP system that is used for Heks’nKaas and the Zuivelhoeve. Also van der Poel has its own logistics partner (Müller Fresh Food Logistics (MFFF), located in Holten). In addition, storage space is rented from Müller in Holten, because in Hengelo the storage capacity is very limited. As already pointed out in this part, external storage space for Van der Poel Desserts is rented in Holten. At this location all end products, raw materials and packaging of Van der Poel Desserts are stored.
When raw materials and packaging are ordered, these are first delivered in Holten. If the raw materials and packaging are needed for production in Hengelo, these have to be transported from Holten to Hengelo. And vice versa once production is finished in Hengelo, end products have to be transported from Hengelo to Holten. From there the end products can be delivered to the customer.
Customers of van der Poel dessert are located all over Europe. Customers are supplied from Holten mainly by two different distributors, Muller Fresh Food Logistics (MFFL) and Overnight. About ten different retail chains in Germany are supplied by Overnight. Other customers in Germany, Belgium and the Netherlands are supplied by Muller Fresh Food Logistics.
Products to customers in other countries in Europe are delivered from a distribution center in Gross Gerau in Germany. From Holten goods are transported to Gross Gerau by Muller Fresh Food Logistics, and from Gross Gerau these products are distributed to the customer.
The trasnport costs from Gross Gerau to the customers in other countries in Europe are reflected to the customer in the cost price of the goods.

The total operational costs for Van der Poel Desserts in the current situation are: €824,902.09

Alternative scenarios: Current stock levels
The alternative locations for a warehouse that were investigated are, a warehouse for Van der Poel Desserts in Raalte (scenario 1), a warehouse for Van der Poel Desserts in Hengelo (scenario 2) and a warehouse for Zuivelhoeve Vers in Twekkelo (scenario 3). Next to these scenarios, also for both subsidiaries we determined what the optimal location for the warehouse would be based on minimizing the transport costs. This is done by applying two location-allocation models. Surprisingly for Van der Poel Desserts, the optimal locations found using these two methods are the same as the locations in scenario 2 (Hengelo) and for Zuivelhoeve Vers this was the same location as the location in scenario 3(Twekkelo).
First the method for finding the optimal location is explained and then the three given scenarios are explained.

*Finding optimal location*Location-allocation models are used for calculating an optimal location on the basis of minimizing the transport costs (Van Goor & Visser). For Zuivelhoeve Vers and Van der Poel Desserts we want to know what the most ideal location is for a warehouse based on the existing transportation costs to the customers and the production locations. There are different models to calculate the optimal location. In this research we used two models to see if they have the same optimal location as an outcome:

* Using Euclidean (straight line) distances, using this manner there is only one way to get from point A to point B.

B

A

* Or using Manhattan distances, using this manner there are multiple ways to get from point A to point

B

A

A drawback of these location- allocation models are that they only focus on the transportation costs per unit or quantity per km that is transported and it should be kept in mind that there are many more factors that play a role in the choice of a location, like the infrastructure, the possibilities of the distributor and the wishes of the personnel.
That is why these location-allocation models for this research can only take into account the transportation costs from the production location to the warehouse and the costs from the warehouse to the customer. But in real-life, since transportation is outsourced, transport from the warehouse does not go directly to the customer, but via a distribution center of the distributor and costs are involved for this extra stop.

For calculating the optimal location of a warehouse using Euclidean distances, the successive approximation method is used. The outcome of the successive approximation method gave Hengelo as optimal location for Van der Poel Desserts and Twekkelo as optimal location for a warehouse for Zuivelhoeve Vers. Which are the same locations of scenario 2 and 3,respectively. For calculating the optimal location of a warehouse using Manhattan distances, the exact method is used. The outcome of the exact method gave also Hengelo as optimal location for Van der Poel Desserts and also Twekkelo as optimal location for a warehouse for Zuivelhoeve Vers. Since the same locations as scenario 2 and 3 are the outcome of the location-allocation models, we do not consider these two optimal locations as two new scenarios.

*Comparing scenarios*

* In scenario 1, Raalte was investigated as alternative location for the warehouse of Van der Poel Desserts. Management of Roerink Food Family thinks it is undesirable that all logistics and warehousing of Van der Poel are separate from that of the rest of Roerink Food Family. A scenario that Roerink Food Family wanted to have investigated is when the external storage location in Holten closes and that all end products, raw materials and packaging of Van der Poel Desserts that were stored in Holten are now stored in Raalte. In this case the external storage location in Raalte must be expanded. The expansion will imply that there will be 3000 extra pallet places of cold storage and 1500 extra pallet places of ambient storage, that can only be used by Van der Poel Desserts.
The transport costs between the warehouse and the production site and to the customer have been based on transport cost rates of the distributor of Zuivelhoeve Vers (Nagel). Total operational costs per year for this option are: €552,696.44.
* In scenario 2 we investigated Hengelo (Westermaat) as an alternative location for the warehouse of Van der Poel Desserts. Another Scenario that Roerink Food Family had in mind for storage of Van der Poel Desserts is building a new storage location of 3000m2 in Hengelo (Westermaat). Which means that the storage location will just be 10 kilometers away from Van der Poel Desserts production location in Hengelo.
The transport costs between the warehouse and the production site and to the customer have been based on transport cost rates of the distributor of Zuivelhoeve Vers (Nagel). Total operational costs per year for this option are: € 602,053.14.
* At last in scenario 3, Twekkelo was investigated as alternative location for the warehouse of Zuivelhoeve Vers . Roerink Food Family is thinking of building extra storage capacity next to its production location in Twekkelo. The result of this expansion is that there will be 900 PP of extra ambient storage, 530 PP of cold storage and 2250 PP of refrigerated storage. This implies that all storage of Zuivelhoeve in Raalte and Oldenzaal, as it was in the current situation, has to move to Twekkelo. Total operational costs for this option are : € 2,051,213.79

When comparing the operational costs per year for the alternative scenarios with the current situation under the current stock levels, we saw that Raalte is the most profitable location for both subsidiaries. Van der Poel Desserts has operational costs of €552,696.44 in this situation versus € 824,902.09 in the current situation. For Zuivelhoeve Vers this means that the warehouse of the current situation in Raalte (€1,919,117.70) is better than the alternative scenario in Twekkelo (€ 2,051,213.79). But in the current situation there was also storage in Oldenzaal, which is undesirable, therefore storage of Zuivelhoeve Vers in Oldenzaal should move also to Raalte in this situation.

Alternative scenarios: Future stock levels
Next to what the optimal location for a warehouse would be under the current stock levels, Roerink Food family also wanted to know what the best option would be in the future (3-years from now). The stock levels of Van der Poel Desserts and Zuivelhoeve Vers have therefore been forecasted, using the long-term forecasting model “ forecasting by decomposition”.
These stock levels have been forecasted for three different future growth scenarios, 10%, 30% and 50% growth with compared with the stock levels of 2014.
To determine the optimal location for a warehouse under these different future growth ratios, we formulated an ILP-model both for Zuivelhoeve Vers and Van der Poel Desserts. In this integer linear programming model the future stock levels, transport costs to each group of customers, internal transport costs and storage costs can be inserted. The output of the ILP-model gives the operational costs as objective and indicates where the goods should be stored every week of the year. In the integer linear programming model we also inserted renting storage space as an extra storage option. This is done in case that if in just a few weeks of the year the capacity level of a warehouse is exceeded. By using this model, we came to the following conclusions regarding the optimal location for a warehouse under the different future growth scenarios:

*Van der Poel Desserts:*

* **10% growth ratio**: Expand the warehouse in Raalte (scenario 2), so that goods of Van der Poel Desserts can be stored here. Operational costs per year are: €533,616.59
* **30% growth ratio**: the optimal location for a warehouse under this growth ratio is also in Raalte. In the (few) weeks that the capacity is exceeded, extra storage space should be rented. Operational costs per year are: €610,294.75.

*Zuivelhoeve Vers*

* **10% growth ratio:** Optimal location for the warehouse is in Raalte. When the capacity level is exceeded, part of the expansion of the warehous in Raalte that is actually to be used by Van der Poel Desserts can also be used by Zuivelhoeve Vers. This is only possible if the expected growth ratio of Van der Poel Desserts is not more than 30 %. Operational costs per year are: €2,273,034.86
* **30 % growth ratio:** Optimal location for the warehouse is in Raalte. When the capacity level is exceeded, part of the expansion of the warehous in Raalte that is actually to be used by Van der Poel Desserts can also be used by Zuivelhoeve Vers. This is only possible if the expected growth ratio of Van der Poel Desserts is not more than 30 %. In the weeks that the capacity is still exceeded, extra storage space should be rented. Operational costs per year are: € 2,734,068.12

**50% growth ratio:** When for one of the subsidiaries it is expected that the stock levels will grow with 50% with respect to the stock levels of 2014, only one subsidiary can stay using he warehouse in Raalte. For the other subsidiary the second best location should be used. This means there are two options:

* 1. Zuivelhoeve Vers will stay using the warehouse in Raalte and gets the storage space that was dedicated to Van der Poel Desserts, this leads to €2,727,435.08 as operational costs for Zuivelhoeve Vers in this option.
	For Van der Poel desserts the most profitable alternative location has to be used, this is building a warehouse in Hengelo, this leads to €1,011,659.18 as operational costs for Van der Poel Desserts in this option. Together for both subsidiaries the total operational costs are: € 3,739,094.26.
	2. Van der Poel Desserts will stay using the warehouse in Raalte and gets the storage space that was dedicated to Zuivelhoeve Vers, this leads to € 707,601.54 as operational costs for Van der Poel Desserts in this option. For Zuivelhoeve Vers the most profitable alternative location has to be used, this is building a warehouse in Twekkelo, this lead to € 2,985,351.22 as operational costs for Zuivelhoeve Vers in this option.Together for both subsidiaries the total operational costs are: € 3,692,952.76.

Option 2 is cheaper, but involves more changes for Roerink Food Family with respect to the current situation. Therefore a trade-off has to be made by the management between the amount of changes and the costs involved.

Recommendations
We recommend to the company, in the coming year, to expand the warehouse in Raalte. In this way both companies can use this location for their warehouse.
The warehouse of Zuivelhoeve Vers was already located in Raalte, only the raw materials/packaging that were stored in Oldenzaal have to be moved to Raalte . This has to be done as soon as possible.
The warehouse of Van der Poel Desserts is now located in Holten, to move all storage at once to Raalte would be unwise. First the raw materials/ packaging should be moved to the warehouse in Raalte. This is also to gain insight in how well the warehouse in Raalte works out for Van der Poel Desserts.
When the company is positive about using the warehouse in Raalte for raw materials/ packaging also storage of the end products can be moved to Raalte.
During this period it is necessary to monitor the stock levels and to make new future predictions for both subsidiaries. When the stock levels are expected to grow not more than 30% (compared with stock levels of 2014) in 3 years from that moment, the warehouse in Raalte can still be used for both subsidiaries.
But when the stock levels are expected to grow more than 30% in 3 years from that moment, it has to be decided, for which subsidiary the storage has to move to another location, since the capacity in Raalte will become too small to store goods for both subsidiaries.
My advice is to stay using the warehouse in Raalte for Van der Poel Desserts and build a warehouse in Twekkelo to store the goods for Zuivelhoeve Vers. When looking at the costs this is not only the better option, also when looking at the changes involved there is no longer a preference for keeping the warehouse of Zuivelhoeve Vers in Raalte. This is because both subsidiaries were already located in Raalte and the storage of Van der Poel Desserts has already moved once to another location (from Holten to Raalte). When moving this again for Van der Poel Desserts, it involves again more changes for Van der Poel Desserts.